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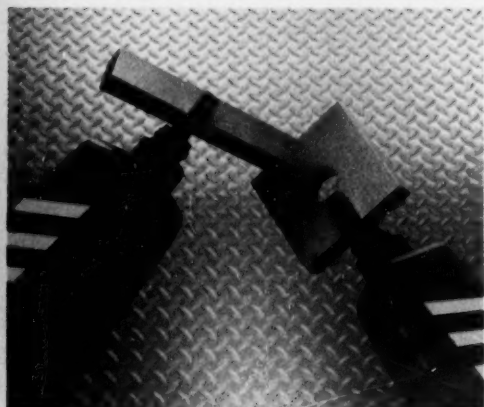
MANUFACTURING AUTOMATION'S PROBLEM

Why the MAP Networking Standard
Isn't Fitting Into Manufacturers'
IS Strategies



DATAMATION[®]

FOR MANAGERS OF INFORMATION TECHNOLOGY WORLDWIDE



Manufacturing Automation's Problem 32

BY PARKER HODGES When it first came on the scene some seven years ago, the Manufacturing Automation Protocol was a powerful symbol of user influence on industry standards. But, today, the world's first user-developed networking standard for factory automation has attracted only a meager following, despite backing from powerful General Motors Corp.

Cover Photography by David Bradley

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BY DWIGHT DAVIS Despite a slowdown in the U.S. economy, the industrial and commercial giants in a dozen fields are continuing to invest in information systems and resources at a pace that matches the overall growth of their businesses. Collectively, these 120 industry leaders are increasing their IS investments by 10.5% this year.

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BY SUSAN KERR Standards are making it easy to connect electronic mail systems. But locating people on all those systems is becoming a problem. A newly approved international standard may soon make available a worldwide e-mail address book. However, mail network providers say needed technical and tariff agreements may stall widespread use until the mid-1990s.

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BY BARRY FLOYD AND BOAZ RONEN Introducing automation into an office won't necessarily increase productivity. But, certain techniques now employed to analyze shop floor performance can be used to maximize office automation investments.

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MAP: A Faded, Yet Durable, Symbol

When the idea for a Manufacturing Automation Protocol (MAP) was first advanced by General Motors Corp. and others, it was greeted enthusiastically by manufacturing companies. MAP's warm reception showed, it was believed at the time, that American industry was indeed serious about competitiveness. MAP, which offers a standard way for elements of the manufacturing process to communicate, became a symbol of progressive thinking about the related needs of information systems and business.

But now the applause that greeted MAP has faded, and manufacturing companies have turned their attention to other standards and protocols. As New York bureau manager Parker Hodges reports in this issue's cover story, "Manufacturing Automation's Problem," page 32, "Seven years after its birth, the network standard that promised interoperable and interchangeable systems on the factory floor can't seem to get anywhere Inconsistencies between initial and current specifications, scant products and a lack of upper management support have idled this network technology even as other vendor-independent network standards zoom along."

The problems that developed during MAP's brief time in the sun may warrant relegating it to the place where all good, but unworkable, ideas go. But the laudable motive behind the effort remains. The manufacturing industry is clearly determined to improve its processes, get its information systems house in order and compete effectively. Issues such as time to market, quality and cost reduction are real and won't fade away. Other standards and protocols may succeed where MAP has failed.

So while MAP may someday become a footnote in information systems history, it will remain an important symbol of rational thought in the decade that is about to close.



HODGES: Getting a fix on manufacturing

Photograph by David Bradley

A View of Another Manufacturing Trend

Distributed processing is an IS trend that is sweeping through manufacturing, as well as other industries. The benefits of organizing IS resources this way are many, but so are the hurdles that must be overcome. As New England bureau manager Chris Sivula reports in "Georgia-Pacific's MRP II Test," the big textile manufacturer went through many trials and tribulations to implement an MRP II system at its tissue paper plant in Bellingham, Wash. To find out how Georgia-Pacific's effort to achieve more efficient production is progressing, turn to page 95.

And for detailed information about how much manufacturing companies—as well as top firms in 11 other industries—are spending on IS, check out our annual industry-by-industry spending survey, appearing on page 42. Overall, the top 10 companies in the 12 sectors surveyed will spend an estimated \$51.5 billion this year on IS, up 10.5% from 1988.

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Manufacturing Automation's Problem

The world's first user-developed networking standard, the Manufacturing Automation Protocol, has attracted only a meager following. Has MAP become a victim of the standards movement?

BY PARKER HODGES

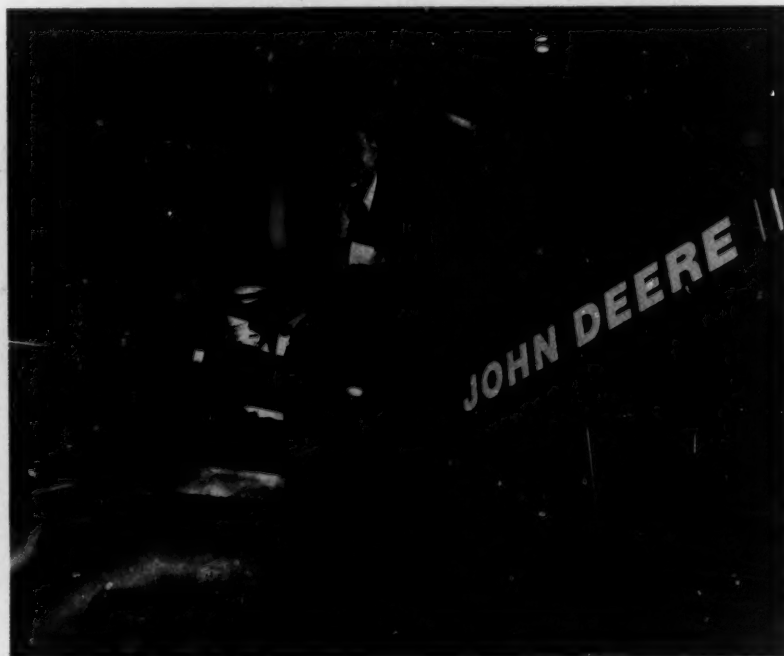
Manufacturing Automation Protocol (MAP), a powerful symbol of user influence on industry standards and a once shining example of vendor-independent computer networking standards, has stalled.

Seven years after its birth, the network standard that promised interoperable and interchangeable systems on the factory floor, can't seem to get any-

where, despite the backing of one of the world's most formidable companies, General Motors Corp. Inconsistencies between initial and current specifications, scant products and a lack of upper management support have idled this network technology even as other vendor-independent network standards zoom along.

MAP's lofty ambition of connecting dissimilar machines on a single network once promised to galvanize manufacturing IS executives into purging their present hodgepodge of proprietary factory networks. Such networks are governors on the engines of industry, inhibiting different makes of equipment from sharing data. In contrast, MAP offers a common communications protocol for factory computers, robots and programmable controllers (the intelligent guides for machine tools and robots) in an industry standard network topology.

Where seven years ago MAP alone promised this vendor independence, networks supporting non-MAP Open Systems Interconnection (OSI) protocols are now available elsewhere and seem poised to bypass MAP. For instance, Digital Equipment Corp. next year will deliver OSI compliance as part of its DECnet protocol. Already some early MAP users and vendors have delayed implementations or abandoned the protocol altogether. For example, Seattle-based Boeing Co., an early MAP supporter, recently bypassed MAP for a proprietary protocol in a new factory network. Even staunch believers in the General Motors inspired



Photograph by Marc Barlow

DEERE'S GARY BLUNCK: MAP installations suffer from product scarcity.

Other countries are recognizing the value of MAP, while the U.S. twiddles its thumbs.

protocol say its future may no longer be in their hands.

For instance, two years ago, General Dynamics Corp. of St. Louis began testing MAP 2.1, which is the first version of the protocol to have products supporting it. But now a new version, 3.0, has replaced 2.1, hindering further use at General Dynamics and other companies. "[MAP] 3.0 is still the goal, but until 3.0 has been implemented [in products], I'd be reluctant to recommend this as our strategy," says MAP project manager Mitch Baloga. In the meantime, implementation of other factory networks continues. "Business has got to go on," says Baloga.

That's also the situation at farm equipment maker Deere & Co. of Moline, Ill. A MAP user with more than 100 MAP nodes, Deere recently installed a non-MAP shop floor labor-reporting system because virtual terminal support on MAP wasn't available. "We just did not have the assurance those products would be available soon enough to do the installation," says Deere technical services project manager Gary Blunck. This lack of product choices will prevent smaller companies from utilizing MAP for another five to 10 years, he says. "Larger companies are going to be more aggressive," he predicts.

And General Motors may be one of them. The auto giant will spend about \$10 million on MAP 3.0 products each year for the next two years, according to Mike Kaminski, MAP manager at General Motors. West German programmable controller kingpin Siemens AG also has pledged full backing for MAP 3.0. But so far the GMs and Siemens of the world haven't sufficiently convinced many other manufacturers to push MAP along.

Putting MAP on the Map

To raise MAP awareness and recruit other large companies, the North American MAP Users Group last year formed the Information Technology Requirements Council (ITRC). In part, ITRC was organized to attract executives from the ranks of the top manufacturing corporations. So far, it has been unable to land even a single chief executive officer.

In the United States, "the industry isn't buying," concedes Paul Eastman, chairman of the Institute of Electrical and Electronics Engineers Inc.'s (IEEE) 802.3 token bus standards committee and marketing manager for broadband and local area networks at Fairchild Data Systems. "Investment is not being made by U.S. vendors," says Eastman.

GM's Kaminski describes the current U.S. outlook for MAP more in sorrow than in anger. "We invented the technology," he says, speaking for U.S. manufacturers in general. "We did it because we wanted to become more competitive. And if we don't watch ourselves, it's going to turn around and bite us. Other countries around the world recognize the value of [MAP], are using it, while we twiddle our thumbs."

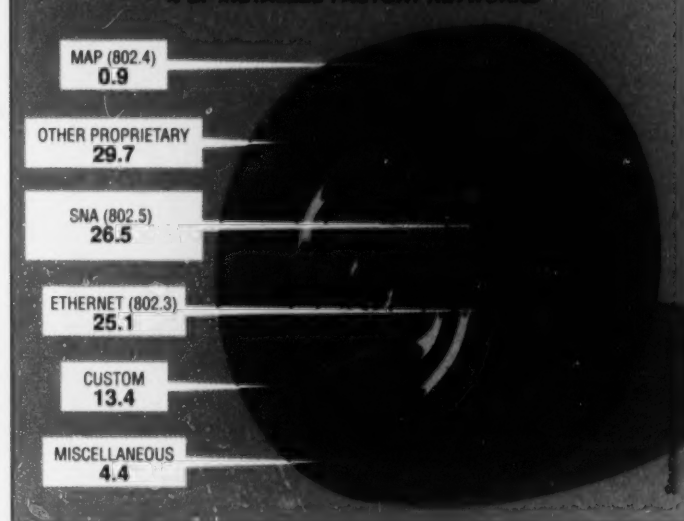
There is anecdotal evidence to support his contention. "A profile of the [potential] MAP customers we are talking to shows about 60% of the activity is in Europe," says Brice Clark, network solutions manager at Hewlett-Packard Co. "The real hot-bed is

in Germany," Clark adds that the remaining 40% is split fairly evenly between users in the United States and the Asia/Pacific area. Lee Reed, research engineer at the Industrial Technology Institute (ITI) in Ann Arbor, Mich., confirms the MAP interest from abroad: "We're getting a lot of requests for technical data from Europe and Japan," Reed says. "MAP

A Weak Showing on the Factory Floor

MAP networking has barely begun to show up on the factory floor, according to a census of installed factory networks.

% OF INSTALLED FACTORY NETWORKS



makes a lot of sense for Europe. The coming of 1992 [when trade restrictions are dropped among the 12 member nations of the European Community] will require this kind of integration compatibility."

Yet, MAP's role outside the United States may simply be a twist on the "grass-is-greener-on-the-other-side-of-the-fence" school of thought. "The perception that there is a lot going on in Europe in terms of actual implementation is just not correct," says Susan McGarry, the London-based managing director of Yankee Group Europe. "There is a lot of interest, but not a lot of cash over the table," agrees Roy Cadwallader, chairman of the European MAP Users Group. "European industry isn't entirely convinced that GM is right in terms of the benefits of MAP."

Waving the Flag

MAP supporters believe the Japanese are ready to exploit the protocol's potential and advance beyond all others. "Starting next year, Japan will come on like gangbusters, delivering whole MAP compliant systems—whole milling machines, whole robots," Eastman predicts. Not everyone agrees, however. "I've heard that threat," says Stephanie Johnson, chief operating officer of the Boston-based Yankee Group and one-time vice president of international operations. "I don't buy it." After discussions with

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Japanese vendors and subsidiaries of U.S. companies, she believes there is not yet a good market for MAP in Japan.

The Japanese can claim one achievement that U.S. and European MAP devotees are still trying to realize: official government support. Japan's Ministry of International Trade and Industry (MITI) en-



CONCORD COMMUNICATIONS' TONY HELIES: His company supplies the bulk of MAP 3.0 modems and just signed an agreement with IBM.

dorses a MAP-compliant factory automation intercommunication system (FAIS) as a national common software. "The Japanese see the advantage of MAP as it has been touted all along," says Eastman. "Not that it has a lower cost per node, not that it will do anything other systems won't do." Unlike executives in the United States, Eastman says, the Japanese clearly understand: "[MAP] makes you vendor independent."

Even though it is not clear if either Europe or Japan holds a clear MAP lead, flag waving by the MAP Users Group has attracted some government attention in North America. Canada and the United States have recently assigned official representatives to the ITRC. And the U.S. National Institute of Standards and Technology (NIST) is cosponsoring seminars promoting the benefits of standardized technology.

So, some observers believe it is too early to count MAP out in the United States. Julius Dorfman of Cimdata Inc., a computer-integrated manufacturing (CIM) research house in Wellesley, Mass., says, "The [MAP] competition between Europe, U.S. and Japan is still a wide open ball game." Furthermore, some believe that MAP support—no matter where—helps countries such as the United States with sizable manufacturing bases. "If the installation and use of MAP and other OSI-compatible protocols grow, countries with the largest manufacturing bases

would benefit proportionally greater," says Charles N. Thurwachter Jr., also an engineer with the ITI.

Still the fact remains that MAP's penetration of the U.S. factory networking market is shallow. Keith Belton of the Yankee Group says that factory networks based on the MAP protocol constitute only 0.9% of the total U.S. factory network base. Proprietary networks, in contrast, make up just shy of 80% of the installed base, with Ethernet (including Digital's DECnet) and IBM's Systems Network Architecture (SNA) networks taking the lion's share.

Eastman suggests that short-sighted, bottom-line-oriented U.S. companies should bear the blame for their reluctance to take up the MAP challenge. But the story is more complicated than simple MBA penny-pinching.

Where MAP Went Off Track

When MAP backers talk about the Enterprise Network Event '88 International, a trade show that took place in Baltimore in June 1988, they call it The Event, and you can almost hear the capital letters. It was to be a launch with bells on and, when the show was planned, users were going to be able to buy virtually everything they needed to put together a MAP 3.0 network for their factories. Well, it didn't go quite that way. Bob Crowder, an industrial consultant whose company, Ship Star Associates Inc. of Newark, Del., specializes in local area networks (LANs) and factory automation, says of the ENE, "People were really pumped up. If ENE had been held later, or products had been available earlier, you'd have a different story."

Although ENE demonstrations were impressive, MAP's then strong momentum was lost in the subsequent dearth of actual products. It wasn't until April 1989, almost a year later, that would-be MAP 3.0 users could buy anything approaching a complete suite of products.

But loss of momentum wasn't just due to that 11-month delay. The first products that met the MAP 2.X specification were shipped in 1986. Only a year later, when larger users were completing their evaluations, did the MAP/TOP Users Group announce that MAP 3.0 would be forthcoming. "MAP was just hitting its stride, when it was announced that 3.0 would be ready in a year. Well, that year turned into 18 months or two years," says A.J. Friscia of Advanced Manufacturing Research Inc. in Cambridge, Mass. "The transition was not handled really well by the MAP community," adds Paul Van Dyke, manager of plant operations market development at IBM.

Furthermore, a lack of available products hasn't been the only issue for MAP. Chuck Gardner, manager for standards and supplier management at Eastman Kodak Co. and a member of the MAP/TOP Steering Committee says that, unlike the situation at GM, many industrial corporations' support for MAP has not come from high up the corporate ladder. Gardner says that the users in the MAP/TOP Users Group "weren't carrying any vice presidential stripes."

"If you asked any of our members about their vice

European industry isn't entirely convinced that GM is right in terms of the benefits of MAP.

presidents, they'd say the VPs have warm, fuzzy feelings [about MAP]. However, if pressed, the [vice presidents] would stutter and stammer and say, "There's an active group out there, and we believe that what they're doing is to our advantage," but that might be where it ended," Gardner says. The ITRC's inability in the last year to attract any CEO members suggests that hasn't changed. Whether top executives are interested in such technical issues is debatable. "We do not try and sell MAP per se [to upper management]," says Deere & Co.'s Blunck. At such presentations, Blunck stresses productivity gains and reduced costs, not protocols or standards.

MAP wouldn't be the first IS initiative to be stymied by lack of high-level support. Perhaps an even greater concern is the fact that it has failed to provide one of the keys to advanced networking: version compatibility. MAP 2.X and MAP 3.0 use completely different application layers. The top layer of 2.1 uses the Manufacturing Message Format Standard—or MMFS, pronounced "Memphis." MMFS was a collection of words, says Ralph Mackiewicz, vice president of sales and marketing at Systems Integration Specialists Co. (SISCO) of Warren, Mich. The company makes factory automation systems that work with, among others, DECnet and MAP networks. Unfortunately, "MMFS didn't specify how to put these words together. So you'd have GM's Saginaw [Mich.] plant putting a sentence together that would not run at GM's bus and truck plant," he says. It wasn't until MAP 3.0 introduced an alternate format, Manufacturing Message Standard (MMS), that the problem was remedied, Mackiewicz says.

But the change from MMFS to MMS made migration from MAP 2.1 to MAP 3.0 a challenge for users. Joe Farrugia, now Atlanta branch manager for AGS Management Systems Inc., once worked at GM and its Electronic Data Systems Corp. subsidiary. While at GM, he worked on a MAP network at GM's Hamtramck, Mich., plant where Cadillac Seattles are made. Farrugia, currently building an industrial automation product, which IBM is introducing at this month's Autofact show in Detroit, says moving from 2.1 to 3.0 "is more a leap than a migration."

Vendor Migration

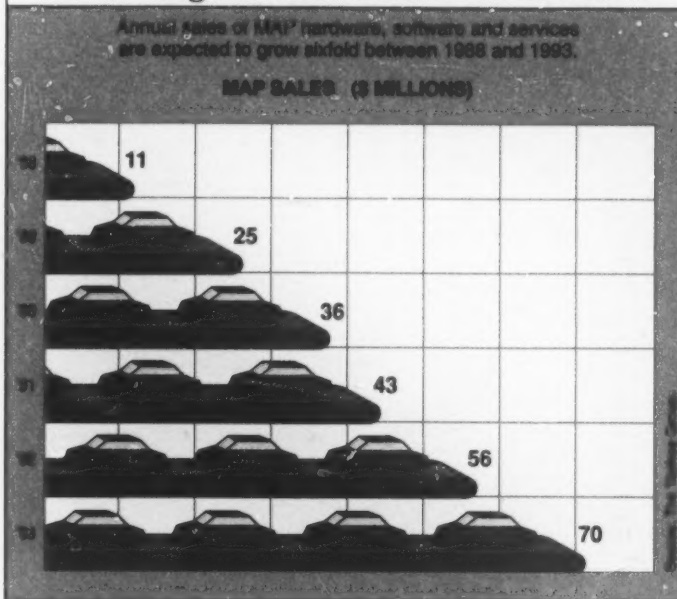
For the Aluminum Co. of America, a MAP 2.1 user at its Alcoa, Tenn., plant, the leap became impossible when its principal MAP vendor dropped out of the market. An early user, Alcoa has a 33-node, MAP version 2.1 broadband network that began operation in May 1987. Today, the network is likely to be replaced by a non-MAP network. "We are considering three or four alternatives, including MAP 3.0, Ethernet and proprietary networks," says John Burke, Alcoa's engineering manager of Tennessee operations.

The decision by Alcoa supplier Ungermann-Bass Inc. to leave the MAP arena is "the major reason for Alcoa's consideration of a new network," says Burke. Ungermann-Bass withdrew from the market when it became clear that migration from 2.1 to 3.0 would involve extensive rewriting of its software. Roger Biery, product line manager of protocols at

Ungermann-Bass, also says the decision was based on economics: "We'd been in the business for four years and had been unable to turn a profit [on it]."

Other vendors have had similar problems turning a MAP profit. Sales of 3.0 products at Allen-Bradley Co. have been sluggish, says Monte Roach, manager of control network products for the Ann Arbor, Mich., factory equipment supplier.

Estimating the Market for MAP Products



Despite their experiences, SISCO's Mackiewicz discounts the problems involved in changing from MAP 2.1 to MAP 3.0, saying some users will be able to transit to 3.0 without significant pain. "It can be a relatively straightforward migration" involving downloading some software and reconfiguring network addressing, Mackiewicz says. The larger problems appeared for those "who wrote complex applications based on MMFS."

There's yet another problem in layers one and two of the MAP specification, the physical and datalink layers. The MAP specification requires a token bus communications standard. But, according to AGS' Farrugia, "most networks aren't loaded to the levels where tokens would be needed."

GM's Kaminski says the reason for the token bus scheme is potential expansion. "Right now, the number of devices on the plant floor is limited. We would expect that number to grow tremendously, not only with GM but with small companies, as well."

"If I'm going to install 10 nodes today, but expand to 100 in two years, I don't want to pull out an Ethernet network and put in a carrierband network. But, maybe, if I'm only going to put in 10 nodes and leave 10, maybe baseband Ethernet is OK. We're not against 802.3. But, as you expand and grow, we know that MAP allows for expansion. We don't know that Ethernet will."

COVER STORY MANUFACTURING

Digital president Kenneth H. Olsen is one who has been vocal in his insistence that MAP's token bus architecture was unnecessary. Yet, the purchasing power of its customers, particularly General Motors, has led Digital at least partially into the MAP camp. A Digital spokeswoman confirmed that the company is field testing Digital MAP 3.0 products. In early August, GM's Kaminski reported meeting with Digital to settle details of its 3.0 implementation. Digital has an enormous lead in the installed base of factory networks. Advanced Manufacturing Research estimates 1988 sales of DECnet topped \$100 million, with some 490,000 DECnet nodes installed.

Ungermann-Bass' Biery says: "The most important thing that MAP offers is OSI [compliance]." And, in addition to token bus, the OSI reference model includes as options at the physical link and datalink levels, token ring and Ethernet. Digital announced

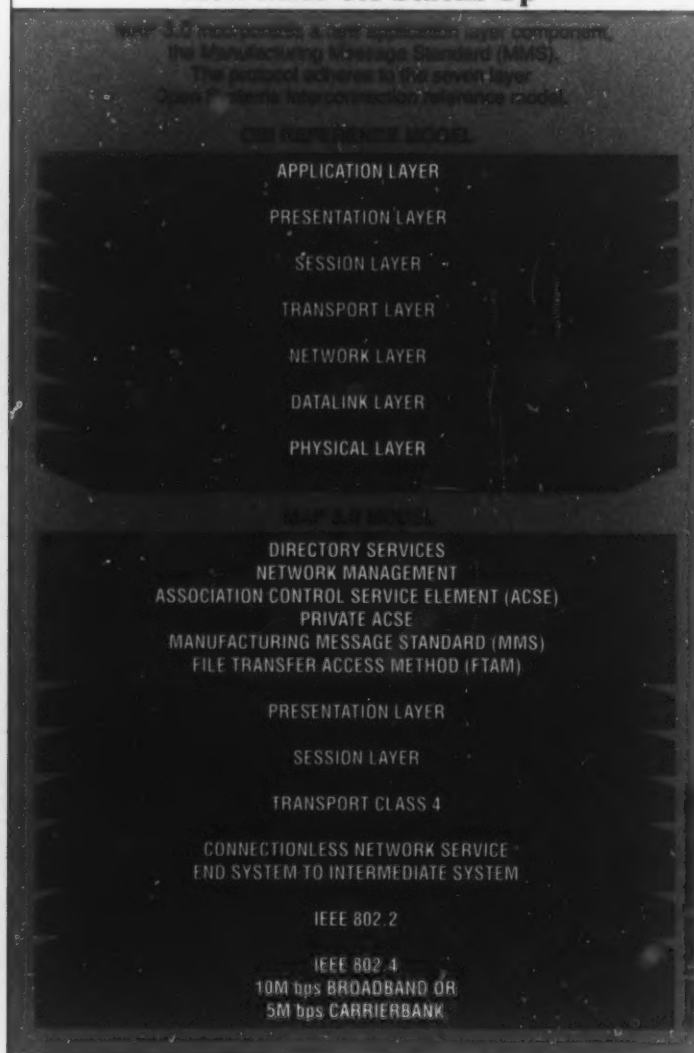
Despite its capabilities, MAP's penetration of the factory-networking market is shallow.

in 1987 that its DECnet strategy would be based on evolving the product to OSI compliance by 1990. The scheme will be called DECnet/OSI Phase V.

Digital's MAP 3.0 entry may give a boost to MAP 3.0. Ship Star's Crowder says, "Until DEC and IBM have 3.0 products, it won't really happen. If you have a corporate strategy committing to IBM or DEC, you aren't going to commit to MAP until they have products. People who have a major commitment to HP and want to go to MAP are in better shape."

At IBM, Paul Van Dyke says, "We have positioned MAP as part of our overall OSI strategy. MAP 3.0 is IBM's strategic LAN for plant floor networks." And Van Dyke adds that IBM is supporting the newer MAP 3.0 MMS standard at the application level, saying "MMS is a vehicle for applications development." Van Dyke also notes that Big Blue has a MAP network installed at its Endicott plant in Binghamton, N.Y., to help build 9370s. The plant is now also turning out IBM's hit midrange computer, the AS/400.

How MAP 3.0 Stacks Up



Will GOSIP Help?

Another potential boost for MAP may come from the federal government. ITI's Reed says that "MAP matches the GOSIP standard." GOSIP, the Government Open Systems Interconnection Profile, is mandated for all U.S. government communications systems installed after August 15, 1990. Kevin Mills, chief of NIST's Systems and Network Architecture Division, notes that "MAP complies with all OSI standards currently existing," adding that, while, "MAP has its own network management standard and its own directory services standard, as yet there are no OSI standards for these functions."

Taken together, these moves may supply what Ship Star's Crowder says MAP now needs, "a recharge." ITI's Reed says he expects shipments of MAP products to grow 20% to 30% over the next few years. However, Friscia of Advanced Manufacturing Research says that MAP 3.0 won't take off for a few years yet: "MAP 3.0 won't begin to take off again until OSI does, in 1993-95, when it becomes clear that the MMS application layer will run on OSI." Still, SISCO's Mackiewicz says MMS is well on its way to becoming an international standard.

For some vendors, MAP 3.0 is already paying off. Tony Helies, president of the privately held Concord Communications Inc. in Marlborough, Mass., whose company makes a full range of MAP-compliant networking products, including diagnostic tools and connections for IBM PC ATs and PS/2s, says, "In our case, it has really taken off this year. Throughout 1989, [Concord's order] bookings have been running 70% over last year." Helies adds: "Every major vendor of automation is in the process of bringing out their 3.0 connections."

For users, however, MAP may eventually wind up being just a symbol, albeit a proud one, of control over their own IS destinies. Other protocols coming under the OSI banner are attracting a wider following and appear ready to subsume MAP as the standard for the factory floor. But when the technological history of the period is written, MAP will be known as the spark that started it all. □

SPECIAL REPORT
INDUSTRY-BY-INDUSTRY
SPENDING SURVEY

OVERHEAD

Despite a slowdown in the U.S. economy, the top companies in a dozen fields of industry and commerce are increasing their IS investment by 10.5%.

U.S. Giants Run a \$50 Billion IS Tab

The industrial and commercial giants of the United States are continuing to invest in information systems and resources at a pace matching the overall growth of their businesses. DATAMATION's annual survey of IS spending by the top 10 corporations in 12 U.S. industry sectors reveals that the top 120 companies will spend an estimated \$51.5 billion this year on IS—up 10.5% from the \$46.6 billion they allocated in 1988 for personnel, hardware, software and overhead associated with information technology management. Such

growth nearly mirrors the rise in revenues for the 110 nonbanking/financial companies in this year's survey, whose fortunes are expected to swell 10% above last year's \$1.74 trillion total.

IS spending as a proportion of corporate revenues will remain at the same 2.3% in 1989 as it was in 1988. But leading U.S. companies will not necessarily each spend their IS dollars in the same way. On the one hand, telecommunications, electronics and automotive/industrial businesses are far and away the most IS intensive among the 11 out of 12 sectors whose revenues we measure. Each is spending more than 3% of its annual revenues on computers, communications and the like. Retailers, food and beverage producers, and oil companies, on the other hand, exhibit far less passion for the wonders of microprocessor and software technology. Each allocates barely 1% of its sales on IS.

Banking and finance, the one sector gauged in terms of assets rather than revenues, obviously sees big dividends in information technology. Commercial banks, brokerage firms and other financial institutions are investing in on line transaction processing (OLTP) systems, databases and other IS-based fi-

**Distribution of IS Funds 1988,
 Overall Industry Averages**



BY DWIGHT DAVIS

What top IS executives at several companies are reluctant to rely on is people.



HARDWARE

SOFTWARE



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SPECIAL REPORT

INDUSTRY-BY-INDUSTRY SPENDING SURVEY

nancial tools to an incredible degree: the sector's IS investments equal nearly 75% of its profits. American Express Co., Chase Manhattan Bank Corp., Citicorp and Security Pacific Corp.—financial institutions renowned for their IS strategies in the past—show every sign of becoming more IS dependent.

What top IS executives at several companies are reluctant to rely on is people. Several are scrutinizing their personnel outlays, which will consume 44% of IS budgets this year. That's down slightly from 1988, when salaries consumed 45% of all IS allocations—evidence that most executives already have started paring back their ranks or moving them out to support business units.

When such cost-slashing measures succeed, the savings are usually reinvested in some other IS area, causing overall IS budgets to remain relatively constant as a proportion of revenues. Most of these liberated IS funds are going into software, judging from this year's survey. Our survey shows top shops will spend 11% of their IS dollars on applications and systems software in 1989—up a point from 1988. IS allocations for hardware and overhead will remain unchanged from last year, with 34% of IS bucks going for processors, private branch exchanges (PBXs) and other hardware. Overhead IS expenses, like outside services, are also holding steady—eating up only the 11% of budgets in both 1988 and 1989.

Behind the numbers is one trend that crosses all industry sectors—the move toward distributed computing. User organizations in finance, health care and other sectors are channeling increasing amounts of computer power away from headquarters operations toward workers themselves via personal computers, workstations and networks. Be-

One trend crosses all industry sectors—the move toward distributed computing.

cause these distributed systems are less expensive than centralized, large-scale computers, they tend to keep hardware spending flat relative to other portions of IS budgets. In reality, however, those hardware dollars are delivering far greater processing power to users than a cursory analysis of this year's survey would suggest.

Distributed computing makes tallying IS budgets difficult, since some corporations break out divisional or line business IS expenditures separately from central IS spending. Our survey attempts to include the total IS spending—central and distributed.

The survey also endeavors to include telecommunications costs related to IS functions within the 120 corporations.

One facet of communications gaining headway in most major companies is electronic data interchange. EDI, as it's known, allows suppliers and their customers to exchange standard business documents, like purchase orders, directly from computer to computer. A growing portion of IS budgets is being devoted to setting up and maintaining such links.

Other technologies in vogue this year are:

■ **Computer-integrated manufacturing.** Every industrial sector from autos to food is trying to increase the productivity of its plants via networked factory systems.

■ **Database management software.** Software that can discern patterns in customers' habits and transactions is in demand, as companies find that tracking those trends buried in their own customer records can be turned into profits.

■ **Computer-aided software engineering.** IS executives are turning to CASE tools as their chief weapon in the fight against the biggest line item on their budgets—personnel. Helping to automate software development reduces the time and dollars consumed by programmers charged with creating mission-critical applications.

■ **Mass storage.** New applications, such as those involving imaging, require far more storage capacity on distributed and centralized computers than previously existed.

■ **Distributed computing.** Hardly a sector isn't taking advantage of the power of today's workstations and local area networks.

Leading companies' emphasis on applying new technology and their willingness to underwrite its use bodes well for the future of the IS industry in the United States. If IS spending among the major companies in these 12 sectors continues to grow at its historical pace, the 1990s may be a far more important Information Age than the decade that's about to expire. □

Dwight Davis is an associate of the Business Research Group, a subsidiary of Cahners Publishing Co. The Newton, Mass.-based BRG was commissioned by DATAMATION to conduct the magazine's third annual industry-by-industry IS spending survey. Davis collaborated with DATAMATION's writers, bureau managers and editors to produce spending profiles of the 12 sectors surveyed this year.

U.S. Industry's IS Shopping Bill

Firms spent almost \$50 billion last year on information technology for everything from finding oil to stocking shelves.

INDUSTRY-BY-INDUSTRY BUDGET SUMMARY, 1988

Industry	IS as % of Rev	IS Budget	Revenue	Profit
Automotive & Industrial	3.2	11,179	349,355	15,550
Banking & Finance	0.6*	6,303	1,050,543*	8,576
Electronics	3.7	7,135	192,834	13,706
Food & Beverage	1.1	1,189	108,088	5,892
Health Care & Pharmaceuticals	2.6	1,570	60,363	6,321
Insurance	1.7	2,545	149,646	6,546
Metal & Metal Products	2.2	1,117	50,785	(290)
Petroleum	1.3	3,670	282,290	17,190
Process Industries	2.1	2,978	141,810	11,197
Retail	0.8	1,583	197,834	4,989
Telecommunications	4.0	5,294	132,361	8,980
Transportation	2.6	1,979	76,113	2,991
Totals	2.3**	46,542***	1,741,479**	101,648

*Assets, rather than revenues, are indicated in the Banking & Finance category.

**Based on revenue and budget totals from all industry sectors other than Banking & Finance.

***Includes the Banking & Finance expenditures.

All dollar amounts are in millions.

Source: Business Research Group.

Car and Plane Makers Fuel Up With CAD, AI

Led by impressive sales at the Big Three auto makers and substantial orders for new passenger aircraft, the automotive and industrial sector racked up revenues of \$349 billion in 1988, replacing the top 10 petrochemical firms as the No. 1 revenue generator. More important, the sector continued to fuel its growth with information systems—spending 3.2% of its revenues on the technology resources needed to keep car showrooms stocked, jet aircraft flying and other industrial pipelines full. That translates into a staggering \$11.2 billion cumulative IS budget—far outdistancing the \$7.1 billion spent by last year's second-place industry, electronics.

Car and plane manufacturers also continue to outpace all other companies in the amount of their budgets devoted to hardware acquisitions. They directed 44% of their IS budgets, or \$4.9 billion, to the coffers of computer and communications equipment vendors last year. The buying power of car and plane customers is so overwhelming, in fact, that many IS products are developed specifically to address their needs and only later marketed to broader industry segments.

Computer-aided design (CAD), engineering (CAE) and manufacturing (CAM) systems often are christened on the factory floors of General Motors Corp. and Boeing Co. The reasons for this hardware in-

Many IS products are developed specifically to address the needs of the auto & aerospace companies.

fatuation are apparent when one considers the nature of the sector's businesses. Every aspect of its operations—from design and manufacturing to documentation to employee records—is highly dependent upon automation and communications.

Can IS Help Fight Foreign Competition?

These car makers and aerospace firms are expected to suffer some as the Pentagon's purse strings are drawn tighter. But pressures to scale back the defense budget won't have much of an impact on IS spending for several years, if at all. Rather, to fight off foreign competitors, IS expenditures are expected to remain fairly high on the assembly lines of Detroit and in the hangars of the Northwest, as U.S. producers attempt to match or exceed the efficiencies of their Japanese and European rivals.

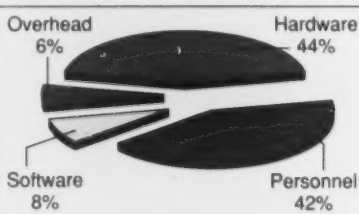
As part of that effort, no other sector has invested so much in CAD and CAE. Workstation vendors as well as sellers of high-end graphics engines, minicomputers and even supercomputers have found ready buyers in Motor City, Seattle and elsewhere on the industrial map. Increasingly, product prototyping is done computationally, rather than by building scale models, with sophisticated 3-D graphics packages, computational fluid flow algorithms and other advanced simulation and analysis techniques.

Factory automation remains the most visible of the car manufacturers' computer-based activities. But much of the expense for robotics, numerically controlled machines and other factory-floor systems falls outside the corporate IS budget. Connecting factories with other departments, such as engineering, inventory and the business offices, however, does fall within the IS purview.

Networking, in fact, constitutes a sizable proportion of the IS budget in this sector. The problems associated with designing, prototyping, manufacturing, testing and marketing new cars and planes can best be tackled as a group effort. It is becoming increasingly rare for designers to work in isolation from manufacturing engineers, or for these engineers to function without marketplace feedback. The auto manufacturers are also heavily dependent upon terrestrial and satellite communications links between their plants and thousands of local dealers.

Both the auto and aerospace companies invest heavily in developing their own advanced technologies, including long-standing work in artificial intelligence. In-house development projects using AI techniques continue at the leading companies in this sector, despite the bad press AI vendors have received during the past year as they struggle for viability. Whether as an expert system that helps diagnose a malfunctioning factory tool or as a natural language system that lets users query databases with English-language questions, AI is gradually beginning to produce benefits. □

Distribution of IS Funds, 1988



The Top 10 in Autos & Industrials

Car and plane manufacturers outpace all other companies in the amount they spend on hardware.

Company	IS Intensity	Revenue (\$ Mil)	Profit (\$ Mil)	FY End
General Motors	+	121,085	4,856	12/31
Ford	-	92,446	5,300	12/31
Chrysler	-	35,473	1,050	12/31
United Technologies	+	18,088	659	12/31
Boeing	+	16,962	614	12/31
Tenneco	=	15,707	822	12/31
McDonnell Douglas	+	15,072	350	12/31
Rockwell International	+	11,946	812	9/30
Allied-Signal	-	11,909	463	12/31
Lockheed	=	10,667	624	12/31

Source: Business Research Group

Finance Firms Invest In Open Systems

Banking and finance sector leaders rely heavily on computer and communications-based services to distinguish themselves from one another. As in other service industries, spending on intelligent information systems has long been seen as an essential part of this sector's strategic and competitive successes. Data constitute the main commodity for banks and brokerage houses, and this sector has been in the vanguard in pushing for and adopting leading-edge IS technologies.

As in previous surveys, the IS budgets of banks and brokerages have been calculated as a percentage of assets, rather than as a proportion of revenues. By comparison with 1987, during which several of the leading firms and the overall sector showed considerable losses, 1988 was a profitable year. The top 10 firms posted combined profits of \$8.6 billion in 1988 on assets of more than \$1 trillion. Of these assets, 0.6% went to IS budgets, which totaled \$6.3 billion.

The financial services sector is particularly amenable to IS outlays in the area of database management systems, transaction-processing software, fault-tolerant systems and telecommunications networks. Of the newer technologies coming down the line, high-speed image processing is attracting interest at such firms as Security Pacific Corp. in Los An-

Financial firms are particularly amenable to IS outlays in the area of database management systems.

geles, which is ready to sign some big checks for document management systems. The banking and finance sector as a whole stands to realize significant benefits from this technology, which allows paper records to be digitized, stored and electronically transmitted.

Cashing in on Personnel

These companies are innovative in personnel issues, as well as technological ones. They have led the way in establishing the chief information officer (CIO) position or its equivalent. While other industries have debated the need for a corporate-level post to oversee the acquisition and exploitation of IS, the financial services sector has moved rapidly to embrace the concept.

Not everybody in the sector, however, embraces the notion of paying their IS chiefs and staffs the big bucks that Wall Street's IS wizards command. Banks

pay their IS employees less than the brokerage and credit card firms, which often lead all other industry sectors in employee compensation. In fact, the banks and brokerage houses tend to cancel one another out in this regard: the overall 45% of IS budgets spent on personnel is identical to the industrywide average.

One of the most difficult and expensive jobs the CIOs at

these merger-minded firms must address is the integration of disparate computer and communications systems. In recent years, hundreds of millions of dollars have been spent by all industries on software to link incompatible systems or replace the systems altogether.

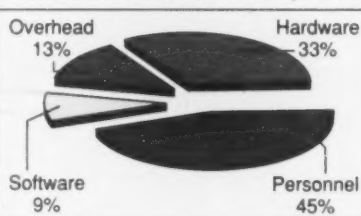
The banks and brokerages are thus acutely aware of compatibility issues, and they are attempting to implement corporatewide standards for IS acquisitions.

Aiding this sector and others is the growing trend toward open systems architectures—models for computers, communications and software that conform to accepted industry standards. In the geographically distributed financial services industry, adherence to common protocols, computer platforms and operating systems is critical. "The technologies of the future have to merge the architectures of UNIX, MS/DOS and MVS," says Fran Dramis, managing director of the Business Technology Organization at Salomon Brothers Inc. in New York City.

The reference to the three operating systems suggests just what platforms will be used to build financial systems superarchitectures—workstations, personal computers and mainframes. "We want products to be as vendor nonspecific as possible," Dramis stresses.

As the financial firms gradually succeed in implementing these standards and the cost of overcoming incompatibilities declines, the percentage of assets devoted to IS may actually drop slightly.

Distribution of IS Funds, 1988



The Top 10 in Banking & Finance

Banks and brokerages are spending big on transaction-processing software and telecom networks.

Company	IS Intensity	Assets (\$Mil)	Profits (\$Mil)	FY End
Citicorp	+	207,666	1,858	12/31
American Express	+	142,704	1,038	12/31
Federal Natl. Mortgage Assn.	-	112,258	507	12/31
Chase Manhattan	+	97,455	1,059	12/31
BankAmerica	+	94,647	726	12/31
Salomon Brothers	=	85,256	280	12/31
J.P. Morgan	-	83,923	1,002	12/31
Aetna Life & Casualty	=	81,415	713	12/31
Security Pacific	+	77,870	639	12/31
Chemical Bank	+	67,349	754	12/31

Source: Business Research Group

Computer Makers Distribute Their Wares

As in past years, the electronics sector leaders continued to spend well above the industry average on IS in 1988. Computer manufacturers and electronics conglomerates last year devoted 3.7% of their revenues to IS tools and resources. Such IS devotion means that the top 10 electronics companies allocated \$7.1 billion of their \$192.8 billion in revenues toward systems that would shorten product development cycles, improve manufacturing operations and create new distribution efficiencies—all competitive necessities in the electronics sector.

Electronics giants such as Digital Equipment Corp., Hewlett-Packard Co. and IBM thus continue to be among their own best customers.

Purchasing their own products at a discount helped the electronics giants to keep their hardware budgets at 30% of their total IS budgets—well below the 34% average for the survey. Personnel costs (47%) and overhead (13%) were above average in 1988. Software outlays related to their own internal IS operations consumed 10% of systems budgets—equal to the average for all 12 sectors.

This year tells a different story for the IS teams in Armonk, Fairfield County, Silicon Valley and other high-technology hot spots. Although hardware investments for the top 10 electronics firms will con-

The industry that makes electronic data interchange possible is only now beginning to exploit EDI.

tinue to fall below average—they'll spend 29% of their IS dollars on computers, while all sectors will devote 34% to them—the sector's spending on IS personnel will jump. Our survey estimates that electronics companies will spend 50 cents on the IS dollar for programmers, business analysts, microcomputer managers and others who work directly with the systems used to run those organizations. That's six points above the industry average. This behavior could be telling for other sectors, implying that the complex information systems now being constructed at computer and other electronics companies—ones that computer vendors are also trying to push on their biggest customers—require a significant investment in human IS skills. They are also investing in computer-aided software engineering (CASE) systems, project management software, and computer-aided design and manufacturing.

Ironically, the industry that makes electronic data interchange possible is only now beginning to exploit EDI's benefits. The electronics industry has lagged behind other sectors, such as the automotive and industrial segment, in implementing EDI. But it is now moving aggressively to set up links with suppliers and customers.

Electronics companies can't blame all of their rising communications costs on EDI,

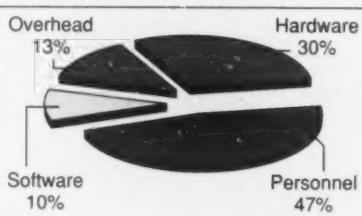
however. Distributed computing plays a part, as well. As more companies in the sectors decentralize decision making and other aspects of their businesses, they become more dependent on networks to tie together the distributed processing power that supports such decentralization.

Network Incentives

Whereas an electronics firm 10 years ago might have used one mainframe to design, manufacture and stock a product, today it's more likely to have designers at 10 locations around the world engineer the product on various workstations; have factories at, say, three locations produce it, with the help of midrange systems; and use warehouses in 50 cities to distribute it, with the help of high-end personal computers. What ties all of that equipment together are local- and wide-area networks. If long-distance telephone rates charged by AT&T, MCI Communications Corp. and other carriers hadn't come down during the past few years, the costs of internal and external networking could have taken up a far greater chunk of the electronics firms' IS budgets.

The electronics companies remain among the most highly automated of all U.S. companies. In boom years such as 1988, when the top 10 companies achieved profits approaching \$14 billion, the incentive to increase IS budgets was strong. Even in hard times—including the softening in some electronics markets seen this year—these companies have an ingrained tendency to turn to high technology as a solution to their problems. □

Distribution of IS Funds, 1988



The Top 10 in Electronics

Electronics companies will spend 50 cents on the IS dollar for programmers, business analysts and other IS personnel.

Company	IS Intensity	Revenue (\$Mil)	Profit (\$Mil)	FY End
IBM	=	59,681	5,806	12/31
General Electric	-	49,414	3,386	12/31
Xerox	=	16,441	388	12/31
Westinghouse	-	12,500	823	12/31
Digital Equipment	+	11,475	1,306	6/30
Unisys	=	9,902	681	12/31
Hewlett-Packard	+	9,831	816	10/31
Motorola	+	8,250	445	12/31
Raytheon	-	8,192	490	12/31
Honeywell	-	7,148	(435)	12/31

Source: Business Research Group

Pursuing flexible manufacturing goals and building extensive networks makes food makers thirsty for software.

INDUSTRY-BY-INDUSTRY SURVEY

FOOD & BEVERAGE

Producers Show Less Hearty IS Appetites

Although computer-integrated manufacturing (CIM) and distributed processing are mainstays of the food and beverage industry, the percentage of revenues that the top companies devote to IS is relatively meager. In 1988, IS budgets consumed only 1.1%, or \$1.2 billion, of the sector's \$108.1 billion in revenues. Only the top 10 retailing companies spent a lower percentage of their sales on information technology.

Food and beverage producers spend less of their IS budgets on personnel than any other industry group—40% in 1988, which is expected to drop to 38% in 1989. In contrast, their software expenditures are the highest percentage of any sector—consuming 15 to 16% of their IS investments.

What makes the sector so thirsty for software? Its pursuit of flexible manufacturing and its extensive distribution and retailing networks. Quality control of vegetables, soft drinks and other goods processed or made by sector companies is such a crucial component of their operations that most spend big bucks on programming their manufacturing systems to monitor critical production parameters.

The processes themselves remain distinct enough from company to company that off-the-shelf solutions are few and far between. Computer-aided software engineering (CASE) tools are helping the com-

panies in this sector tackle the necessary custom programming and maintenance.

CIM Gets Top Shelf Treatment

CIM represents the single most important IS investment at Ralston Purina Co., according to Mary Patterson, CIM program manager at the St. Louis company. The dog chow producer, which ranks No. 12 in revenues in its sector, will be lapping up distribution systems and networking products. The impor-

tance of flexible manufacturing to Ralston Purina is reflected throughout the industry—even for leader Occidental Petroleum Corp., whose Dakota City, Neb.-based IBP Inc. food subsidiary places it in this sector.

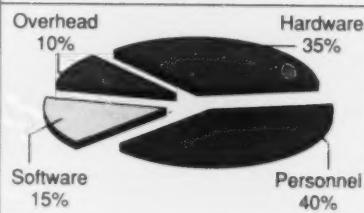
Producing goods with limited shelf lives must be closely coordinated with activity at the retail level. Much of the food and beverage industry's

IS budget, therefore, goes to monitoring customer demand, tracking sales volumes and balancing inventories. As with other industry sectors with wide-ranging suppliers and customers (distributors and retailers in this case), the consumables sector is moving quickly to implement sophisticated electronic data interchange (EDI) systems. EDI links between the corporations and their distributors are particularly important, given the influential linchpin position distributors hold in this industry.

Most companies in this sector are reserving top shelf space for CIM, custom programming and EDI. But they still haven't lost sight of the importance of using information technology to predict and measure demand for their products. Continual surveying of customers' preferences, needs and buying habits heightens demand for statistical analysis software and systems. The data from such analyses can have a significant positive or negative impact on a company's bottom line.

Food and beverage makers, like their peers in the retail sector, deal with commodity-level products that must be transported to numerous locations around the country or the world. To ease this logistics burden, many of the firms build manufacturing plants at several key distribution centers. While this approach simplifies the routing of goods to their destinations, it requires increased IS coordination between the central facility and the far-flung sites. As a result, telecommunications expenses are beginning to eat up a greater percentage of the overall IS budgets in this sector.

Distribution of IS Funds, 1988



The Top 10 in Food & Beverages

Food and beverage producers are thirsty for software but don't have much of an appetite for hardware.

Company	IS Intensity	Revenue (\$Mil)	Profit (\$Mil)	FY End
Occidental Petroleum	+	19,417	302	12/31
RJR Nabisco	=	16,956	1,393	12/31
Pepsico	+	13,007	762	12/31
Sara Lee	=	10,424	325	6/30
ConAgra	=	9,475	155	5/25
Anheuser-Busch	+	8,924	716	12/31
Coca-Cola	+	8,338	1,045	12/31
Beatrice	=	7,505	529	N/A
Borden	=	7,244	312	12/31
Archer Daniels Midland	=	6,798	353	6/30

Source: Business Research Group

Pharmaceutical firms have few rivals in the use of advanced IS tools.

Companies Take Ample Doses of IS Medicine

Hospitals, drug producers and other companies in the health care and pharmaceuticals sector are taking an ample dosage of information systems medicine these days. Supercomputers, workstations, networks and software used to run these medical giants are swallowing about 2.6% of their revenues. The top 10 corporations last year directed about \$1.6 billion of their \$60.4 billion in revenues toward their IS operations, writing a technology prescription that they hope will keep them in good health for the 1990s.

This year, IS spending throughout the sector should remain even as a percentage of overall sales. But there are differences worth noting. Pharmaceutical companies, which dominate the sector, are ramping up their IS investments, as increased competition and regulation forces them to rely more and more on information technology to steer new discoveries through the design and approval stages. Health-care operations, under pressure to control costs as much as possible, are increasing their IS outlays at a slower rate. This difference can be traced in large part to the fact that the health care providers function primarily as service organizations, whereas the pharmaceutical companies are research, development and manufacturing concerns.

Hospitals focus much of their IS budgets on the

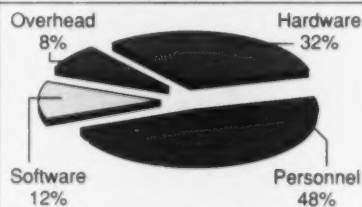
processing and storage of patients' records and bills. Database management software, midrange computers and high-capacity storage subsystems thus continue to draw significant funds. Hospitals, like commercial banks, are developing image-processing techniques to reduce the burden of paper records. But unlike financial firms, hospitals take their time actually acquiring such advanced technology IS tools—devoting far more of their new equipment budgets to leading-edge medical products.

Health-care facilities aren't hesitant, however, to follow the trend toward distributed computing—taking advantage of portable computers, workstations and networks to distribute more knowledge about patients and other aspects of medicine throughout their centers.

Pharmaceutical firms have few rivals in the use of advanced IS tools. Computer

graphics systems, in particular, constitute a growing part of these companies' hardware and software expenditures. Using everything from networked workstations to supercomputers, the drug companies are employing scientific visualization techniques to see drug structures and predict how drugs will interact with molecules. In docking simulations, for example, researchers can watch sequential image frames showing how a drug and its target molecule link—or fail to link—with one another.

Distribution of IS Funds, 1988



The Top 10 in Health Care & Pharmaceuticals

Drug makers' IS spending is up to meet increased competition, but health-care providers are slowing IS spending to cap costs.

Company	IS Intensity	Revenue (\$Mil)	Profit (\$Mil)	FY End
Johnson & Johnson	+	9,000	974	12/31
McKesson	=	7,298	95	3/31
Baxter International	=	6,861	388	12/31
Bristol-Myers	=	5,973	829	12/31
Merck	+	5,940	1,207	12/31
American Home Products	=	5,501	932	12/31
Pfizer	+	5,385	791	12/31
Abbott Laboratories	=	4,937	752	12/31
SmithKline Beckman	-	4,749	229	12/31
Bayer USA	-	4,719	124	12/31

Source: Business Research Group

Working on IS Prescriptions

Such advanced research techniques require talented programmers to write customized software. That's why, perhaps, the sector spends more than the average on personnel and software. The pharmaceutical firms also devote considerable resources to conducting drug trials and to developing statistical models to track the experiments' results. And the compute power devoted to compliance with government regulations and record keeping is significant.

Once drugs are developed, they must be manufactured with precision and, often, in great quantity. Here again, pharmaceutical engineers turn to computer modeling to help develop bulk-manufacturing techniques for drugs that typically are produced in relatively minute quantities during the research phase. Once production techniques are established, exacting computer control is required to ensure drug purity. As a result, pharmaceutical companies are among the most advanced of all firms in their use of precision process manufacturing. □

Big insurers are major users of networks, both local and long distance.

Health and Life Insurers Cut Risks via IS Coverage

Insurance industry leaders spent 1.7% of the \$149.7 billion in revenues they achieved in 1988 on information systems and resources that would allow them to write substantially more policies while considerably reducing their risk. Insurance firms allocated 13% of their overall IS budgets to software in 1988—well above the industry norm of 10%—in large part because of outlays for sophisticated database management programs and transaction-processing applications.

Typical of most service companies, insurers rely heavily on IS to help their agents serve their clients as effectively and efficiently as possible. And, while much of the industry's spending goes for traditional systems and software, some firms are investing in more innovative projects to attain these customer service goals.

Metropolitan Life & Affiliated Cos., for example, is currently wrapping up two pilot image-processing projects designed to improve customer service. One project electronically stores pension department documents and links them to related on-line data. The other project replaces file folders in the New York City-based company's disability claims area.

Once the pilot projects have been assessed, the lessons learned will be applied to other applications throughout the company, says Dan Cavanagh, vice

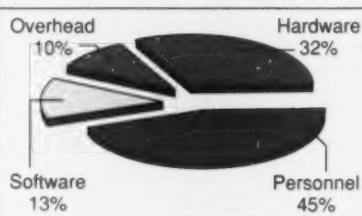
president of management information systems. His company also hopes to save a considerable amount of money by storing documents in electronic form instead of on paper. This may be bad news for filing cabinet vendors, but suppliers of hard disk and optical recording subsystems can expect to benefit from this trend.

One inescapable part of doing business in the insurance industry is the need to communicate with agents across the country. Big insurers are major users of networks, both local and long-distance. Only the banking and financial service firms are as dependent upon telecommunications as are these companies.

But passing information to and from their agents is only part of the task insurers are undertaking. The Travelers Corp., for example, is actively promoting automation at the agencies themselves.

Through its Travelers/EBS Inc. subsidiary, the company attempts to sell to its independent insurance agents integrated systems that automate functions such as accounting and marketing support. Travelers plans to supplement these automation efforts by helping to push common insurance industry system interfaces and document format standards, says Larry Bacon, the company's senior vice president for data processing.

Distribution of IS Funds, 1988



The Top 10 in Insurance

Increasing competition in this traditionally conservative industry is driving some firms to adopt innovative IS technologies.

Company	IS Intensity	Revenue (\$Mil)	Profit (\$Mil)	FY End
Aetna	+	24,296	713	12/31
ITT	+	19,355	817	12/31
Travelers	=	18,986	103	12/31
Cigna	-	17,889	472	12/31
Metropolitan Life	=	15,487	836	12/31
Prudential	=	14,397	877	12/31
American International	+	13,613	1,217	12/31
Loews	=	10,865	909	12/31
Transamerica	=	7,879	346	12/31
New York Life	=	6,929	256	12/31

Source: Business Research Group

Giving Agents an IS Umbrella

Managing health-care benefits is another function receiving more of Travelers' IS resources. To help stem rising health-care costs, the Hartford, Conn.-based insurer offers a wider range of coverage options to its group health care and employee-benefits customers. The new program is intended to enable an employer to offer workers a menu of coverage options from which to pick and choose. Providing such flexibility will require major information system upgrades at the insurer, several of which will be aimed at integrating data from several different benefits programs.

Integration also is an objective of the stepped-systems investments that many insurers are making. The sector already makes on-line transaction processing a policy; nearly 50% of all insurers indicate that they already use OLTP systems. With new products forthcoming from leading OLTP vendors such as Digital Equipment Corp. and Tandem Computers Inc. later this year, one can fully expect insurance companies to up the rate of OLTP use. □

Metal products companies invest more of their IS budgets in design and engineering systems than their ore-oriented brethren.

INDUSTRY-BY-INDUSTRY SURVEY

METAL & METAL PRODUCTS

Metal Makers Bend IS To Fit the Future

Several metals producers had a rough year in 1988, sending the sector's bottom line into the scrap heap. Despite losing \$290 million on \$50.8 billion in revenues, the top 10 metals companies displayed tough information systems mettle. As a group, they spent \$1.1 billion on IS—2.2% of industry revenues, just a tenth of point below the average for all 12 sectors in 1988.

One reason that IS wasn't scrapped last year is that the sector's losses weren't universal; rather, they were limited to a very few companies. LTV Corp. was only one of three companies in the sector to lose money in 1988, but the magnitude of its losses—\$3.2 billion on revenues of \$7.5 billion—dragged down the entire sector's earnings performance. This loss, combined with lesser but still significant amounts of red ink at Combustion Engineering Inc. and Triangle Industries Inc., offset strong profits at firms such as the Aluminum Co. of America (ALCOA) and AMAX Inc.

Metals producers apparently believe that people are as valuable a part of the IS solution as products themselves. The sector will continue to allocate a greater portion of its IS budget to personnel (49%) this year than the survey average (44%), although it is spending less on programmers and the like this year than last. In 1988, 51% of its IS outlays were

spent on personnel. These costs reflect the high price metal benders are paying to restructure in an attempt to stave off bankruptcy and foreign competition.

Companies are consolidating operations to improve efficiencies, and this requires expensive programming expertise to merge unlike hardware, applications and databases. These companies also continue to diversify to reduce the impact of falling profits in their core business. Bringing new operations under the corporate umbrella, many of which have virtually no relationship to the metals business, puts additional strain on the information systems and the IS personnel that must attempt to interact with the newcomers' IS facilities.

Focusing IS on the Process

The key IS investments in this sector remain centered on equipment and personnel directed at the manufacturing process itself.

This focus starts in improved scheduling of raw materials shipments, with many of the firms moving toward just-in-time (JIT) deliveries. As within other industries, JIT manufacturing is being accomplished by establishing electronic data interchange (EDI) links with core suppliers as well as with major customers in the auto and industrial sector.

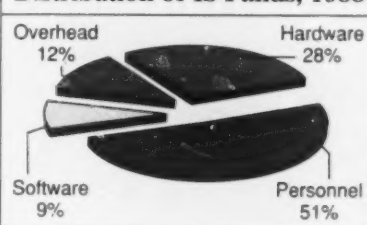
The metals companies hope to use improved coordination between the demand and supply sides to keep their plants running at full capacity for longer periods.

Within the metals plants themselves, computer-integrated manufacturing is being applied to the production processes, boosting both yields and product quality. Each plant can produce hundreds or thousands of variations in its products, making the facilities a natural match for the precision afforded by advanced computer controls. The metals producers look at IS spending as a way to reestablish their reputations as dependable sources of high-quality and low-cost materials.

The companies making metal products, such as The Gillette Co., are likewise establishing JIT programs and EDI links, and are pumping considerable monies into factory-floor IS. Their plants, however, are discrete manufacturing facilities, as opposed to the process plants of the metals producers. As such, they are somewhat more amenable to off-the-shelf digital controls—often avoiding the custom programming expenses being incurred by the metals producers in their plant modernization efforts.

The metal products companies, however, invest more of their IS budgets in design and engineering systems than their ore-oriented brethren. Following the lead of the auto and aerospace firms, these companies are performing more of their research and development with graphics systems and engineering algorithms and less through traditional prototyping means.

Distribution of IS Funds, 1988



The Top 10 in Metals

Metal makers, consolidating operations to improve efficiencies, are investing in pricey programming personnel.

Company	IS Intensity	Revenue (\$Mil)	Profit (\$Mil)	FY End
ALCOA	+	9,795	861	12/31
LTV	-	7,526	(3,154)	12/31
Reynolds	+	5,567	482	12/31
Bethlehem Steel	=	5,489	403	12/31
Triangle Industries	-	4,104	(54)	12/31
Inland Steel	=	4,068	262	12/31
AMAX	+	3,944	741	12/31
Gillette	=	3,581	269	12/31
Combustion Engineering	-	3,484	(245)	12/31
Armco	=	3,227	145	12/31

Source: Business Research Group.

The major oil and gas companies are perhaps the most ambitious of all sectors when it comes to AI.

Oil Companies Exploit As Much as Explore IS

Unlike 1987, when Texaco Inc.'s \$4.4 billion loss severely tarnished the profitability of the oil sector, 1988 was in the black for all of the 10 leading petroleum companies. Total revenues dropped slightly, however, while the 1.3% of revenues devoted to IS budgets remained constant. From their 1988 revenues of \$282.3 billion, this industry's leaders directed \$3.7 billion to IS items.

Long in the forefront of all firms in the exploitation of supercomputer technologies and sophisticated modeling and analysis packages, the petroleum companies have begun to scale back somewhat in such leading edge expenditures. One reason for this is an industrywide shift away from exploration and toward the exploitation of existing reserves—a condition brought on by depressed oil prices, according to one industry source. Still, only the automotive and aerospace companies invest more in commercial supercomputers than petroleum firms.

Decentralization Drives New IS Push

These companies are also facing the problems associated with IS decentralization. "Our IS systems, which were built for monolithic structures, now must face the needs of business unit structuring, where organizations are being split into autonomous

organizations with profit and loss responsibility," says E.D. McDonald, division manager of information processing at Texaco's Houston headquarters. "Whether these systems will be appropriate in a decentralized organization, or whether they will have to be rebuilt is a question that will put considerable pressure on our IS operation," he says.

Despite the importance of the decentralization trend, McDonald identifies electronic data interchange (EDI) as the IS area that will benefit from Tex-

aco's most aggressive spending in future months. Many of Texaco's competitors have similar objectives. The company plans to establish EDI connections with its suppliers and its customers. It also hopes to be a driving force in shaping the sector's EDI standards so that they conform to the intercompany transaction methods traditional to the oil and gas industry. For exam-

ple, Texaco is a member of an American Petroleum Institute subgroup examining ways to arrive at a standardized format for billing one another for gas and oil supplies.

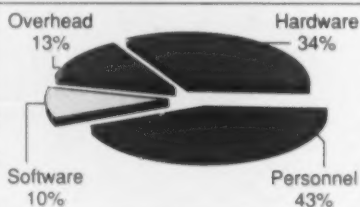
The major petroleum firms have long devoted significant proportions of their IS budgets to supporting and interacting with the distributors and retailers who handle the refined products. Order processing, scheduling, shipping and billing are all highly automated at these companies. Some also run credit card operations, which burdens them with many of the record-keeping and transaction-processing expenses faced by firms in the banking and financial services sector.

Virtually all of the leading oil and gas companies are conducting multiple pilot projects in expert systems, and many have already placed such systems on line. The areas of expertise being coded into computer-based rules include geological analysis, process control, the analysis of chemical spills and the projection of business plan results.

Even though the petroleum companies spend less of their revenues on IS than firms in many other sectors, the funds spent here are often devoted to the most advanced and innovative of IS projects. Because such IS experimentation often is difficult to categorize as a hardware, software or personnel expense, it tends to push the sector's overhead IS expenses above the average. In 1989, oil companies are expected to devote 13% of their IS budgets to overhead, while 43% will go toward human IS resources, 34% to hardware and 10% to software. □



Distribution of IS Funds, 1988



The Top 10 in Petroleum

Oil companies have begun to scale back on leading edge IS expenditures in an effort to exploit existing reserves.

Company	IS Intensity	Revenue (\$Mil)	Profit (\$Mil)	FY End
Exxon	=	79,557	5,260	12/31
Mobil	=	48,198	2,087	12/31
Texaco	-	33,544	1,304	12/31
Chevron	+	25,196	1,768	12/31
Amoco	=	21,150	2,063	12/31
Shell	=	21,070	1,239	12/31
Atlantic Richfield	=	17,626	1,583	12/31
USX	-	15,792	756	12/31
Phillips Petroleum	=	11,304	650	12/31
Unocal	=	8,853	480	12/31

Source: Business Research Group

Managing and operating data-processing facilities is not a strategic function. Using the information is.

INDUSTRY-BY-INDUSTRY SURVEY

PROCESS INDUSTRIES

Shaking up The Process

Dominated by the large chemical and paper companies, the process industry spent 2.1% of its 1988 revenues for information systems—slightly below the average for all 12 sectors in this year's survey. This shortfall can be partially explained by the fact that some of the expensive factory controls the sector acquires are not included in corporate IS budgets.

The 10 process leaders distilled about \$3 billion of their \$142 billion in revenues for IS purposes in 1988. The distribution of this spending was close to the overall industry averages, with slightly more of their budgets (12%) going for software and slightly less (43%) paid to personnel. They spent average amounts on hardware (34%) and IS overhead (11%). This year, they are again expected to invest heavily in software (13%) and hardware (35%) at the expense of personnel (42%) and overhead (10%).

Although obvious differences exist between timber and paper companies such as Weyerhaeuser Co., chemical producers such as DuPont and consumer goods giants such as The Procter & Gamble Co., the process leaders have much in common when it comes to their IS requirements.

Foremost is the need to produce, manage and distribute extensive product lines that typically consist of hundreds, if not thousands, of items. As in all sec-

tors, the process firms are moving toward just-in-time inventory/manufacturing flows. But with such finely segmented product lines, the lists of raw components necessary from extensive supplier networks can be staggering. The only option for maintaining vast and expensive inventories is the ongoing establishment of electronic data interchange (EDI) networks that will balance fluctuating product sales with on-demand supplier shipments.

The top 10 process corporations also rely heavily on computers in their research and development operations. Computers assist in monitoring and simulating chemical interactions and help formulate manufacturing processes that will generate higher quality and higher yields. Local networks connect these and other departments to one another to help ensure that development isn't carried out in isolation from

manufacturing engineers or marketers.

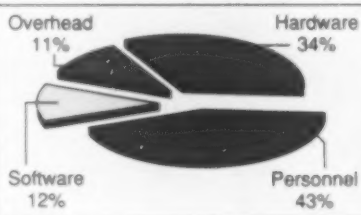
One sector leader, Eastman Kodak Co., has just begun implementing a radically different IS organization plan that could add color to IS life in every sector. The Rochester, N.Y.-based company is spinning off its data center operations to IBM, which will set up and staff a new data-processing center consolidating the operations of four existing Kodak facilities. As part of the agreement, IBM will hire about 275 of the personnel now at the Kodak operations to work at the new data center. Some analysts expect Kodak to cut its data-processing costs by as much as 40% via the innovative arrangement; the company will only say it expects to realize double-digit percentage savings.

A Radical Approach

"In evaluating our IS operations, we concluded that managing and operating data-processing facilities is not a strategic function. Using the information is," explains Henry Pfendt, director of Kodak's information technology service. He says IBM will be able to leverage its existing infrastructure and large customer base to run the data operations much more efficiently than Kodak can. He also promises that the film maker's IS budget will be redirected, not reduced.

Much of the savings realized by Kodak will be spent on developing software applications in the company's various lines of business. "Our strategy is to centralize the infrastructure and to decentralize the applications development," Pfendt says. □

Distribution of IS Funds, 1988



The Top 10 in Process Industries

Process firms are using electronic data interchange to keep chemicals, paper and consumer goods flowing.

Company	IS Intensity	Revenue (\$Mil)	Profit (\$Mil)	FY End
DuPont	+	32,514	2,190	12/31
Procter & Gamble	=	19,336	1,020	6/30
Kodak	=	17,034	1,397	12/31
Dow	+	16,682	2,398	12/31
3M	=	10,581	1,154	12/31
Weyerhaeuser	-	10,004	564	12/31
International Paper	=	9,533	754	12/31
Georgia-Pacific	-	9,509	467	12/31
Union Carbide	=	8,324	662	12/31
Monsanto	=	8,293	591	12/31

Source: Business Research Group

When it comes to retail IS spending, the emphasis can be described in three words: inventory, inventory, inventory.

INDUSTRY-BY-INDUSTRY SURVEY

RETAIL

Stores and Supermarkets Place Limited Stock in IS

As much as Americans love to shop, it doesn't seem to rub off on the shops they buy from, which do the least amount of information systems shopping of any sector in U.S. commerce and industry. The top U.S. retailers spent less than 1% of their revenues on IS in 1988. From revenues of \$197.8 billion, they spent 0.8% on hardware and the like—an IS price tag totaling \$1.6 billion.

The sector does have peculiar IS shopping habits, despite having little money for technology spending sprees. It buys more hardware as a percentage of its overall IS budget than almost any other sector. This year, 40% of its IS dollars will go toward point-of-sale systems, department store midrange systems and other hardware used to move and sell goods. It will allocate slightly more (41%) of its budget for personnel to program POS systems and run other equipment. Retailers will spend an average amount (11%) on software, but less than average on IS overhead (8%).

When it comes to IS spending at these firms, the emphasis can be described in three words: inventory, inventory, inventory. Keeping shelves stocked with fresh food or current fashions requires constant inventory turnovers. As hundreds of thousands of items are ordered, priced, coded and stocked, computer and communications systems

form the linchpins that keep the retail operations from spinning out of control.

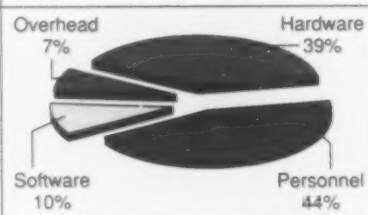
The inherent complexity of inventory maintenance at these companies has been exacerbated by growing industry competition between the discount department stores and the more traditional establishments. Inventory turnover of clothing fashions has accelerated at many of the retailers in an attempt to keep customers returning regularly to the stores.

One of the most visible salvos in the battle for cus-

tomer dollars was Sears, Roebuck and Co.'s much-publicized price-cutting strategy, which the No. 1 retailer implemented in a dramatic blitz earlier this year. The giant retailer reduced the price of its products across the board, from refrigerators to screwdrivers to baby clothes, and consequently had to revamp volumes of electronically stored product records.

As intense as the department store competition gets, these stores can't hold a candle to the supermarkets in terms of inventory management and turnover. Fall fashions may last for only a few weeks before being replaced, but that time is an eternity for milk, bread and cantaloupes. The proliferation of bar code readers at point-of-sale terminals has significantly aided the grocers' ability to track product sales and inventory depletion. Reordering is often handled electronically, as is billing and payment.

Distribution of IS Funds, 1988



The Top 10 in Retailing

Retailers are apparently not born to shop for IS goods, spending less than 1% on information technology.

Company	IS Intensity	Revenue (\$Mil)	Profit (\$Mil)	FY End
Sears, Roebuck	+	50,251	1,454	12/31
K Mart	=	27,301	803	1/31
Wal-Mart	=	20,649	837	N/A
Kroger	-	19,053	35	12/31
American Stores	=	18,478	98	N/A
J.C. Penney	+	14,833	807	12/31
Safeway	-	13,612	31	12/31
Dayton Hudson	=	12,204	287	2/1
May Department Stores	=	11,921	534	12/31
A&P	=	9,532	103	2/29

Source: Business Research Group

Electronic Pricing and Ordering

Perhaps no other industry sector stands to gain so much through the advent of electronic data interchange with suppliers. Using EDI, retailers receive the bulk of their shipments from a limited number of distributors who stock extensive catalogs of goods. This distribution network helps limit the number of store/supplier EDI links required. Supermarkets, however, tend to rely to some extent on small local suppliers, and it will be some time before EDI links with these companies will be cost effective.

Another key IS expenditure for the retailers is the establishment and maintenance of employee record databases. The stores employ hundreds of thousands of people, many on part-time schedules, and offer a variety of compensation and benefits packages. These corporations are thus major purchasers of database management systems and mass-storage subsystems. They are also among those most interested in improved operator/database interfaces, such as natural-language query capability. □

Phone Companies Call On IS For New Services

The leading telecommunications suppliers top all other industry sectors in one important measure of information systems spending. In 1988, they allocated 4% of their \$132.4 billion in revenues toward IS systems and resources that would make calling simpler, expand their service offerings and make it easier for their customers and suppliers to do business with them. That figure is far above the 2.3% average for all 12 of the sectors in our survey.

Measured against profits, IS spending by AT&T, GTE Corp. and others in the sector is nearly as impressive. Although the sector ranked fifth in earnings among the 11 nonbank industries surveyed, its overall IS budget of \$5.3 billion placed it third in IS spending in 1988. Only the auto/industrial and electronics sectors spent more in absolute IS dollars. In fairness to other companies in the sector, the only reason it didn't rank higher in profitability was because AT&T wrote down its obsolete network assets, incurring \$1.7 billion in losses in the process.

The line between corporate IS spending and telecommunications spending is often a thin one at top companies. Long-distance services such as 800 and 900 numbers, for example, are company products, but they fall within the purview of the IS departments.

Many companies are struggling with the choice between expanding their existing systems or upgrading.

Aside from the maintenance and operations of the networks themselves, no task is of greater importance to the phone companies than timely and accurate billing systems. As telecom companies give residential and business customers more service options, billing becomes more complex, and the demands on their IS systems increase. The rise in new services such as cellular phone calls only adds to such complexity. The billing operations usually have some over-capacity built in to deal with peaks in seasonal demand, but this extra processing power is being consumed fairly quickly. Many of the phone companies are struggling with the choice between expanding their existing systems or upgrading to more powerful computers.

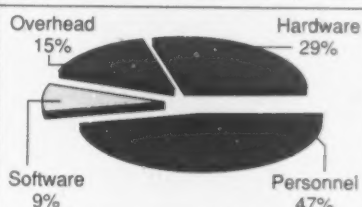
Calling Office Automation

Telecommunications providers are among the most advanced of all companies when it comes to office automation. The vast majority of their office-based employees work on personal computers or mainframe-linked terminals. Customer service departments, in particular, are highly automated, enabling them to call up individual records quickly and effect service modifications remotely. The top 10 companies thus invest heavily in personal computers and in off-the-shelf software such as word-processing and spreadsheet packages. They are, appropriately, also big buyers of local area networking and electronic mail products.

AT&T's divestiture is still having a ripple effect on the sector's IS spending. The seven regional Bell operating companies (RBOCs) created by the 1984 breakup are still in the process of consolidating the different computer systems they inherited from the local telephone companies. Some incompatible systems are being linked via applications software developed by in-house IS staff at regional Bell companies, permitting necessary data exchanges. In other cases, the RBOCs have standardized on the dominant or most cost-effective system, such as computers that run the UNIX operating system. In such cases, they are replacing outmoded hardware and software, writing them off their balance sheets as obsolete assets. The short-term strain on profits created by such write-offs pales in comparison with the long-range gains in efficiency created by standard systems and software.

The field maintenance staffs of the telecommunications companies depend on extensive backup support from the central office computers. But the advent of powerful and lightweight laptop computers is placing more processing power in the hands of the field personnel themselves. Equipped with modems, the laptops can be linked to the central databases of telecommunications companies to upload and download information pertinent to repairs, installations and troubleshooting operations.

Distribution of IS Funds, 1988



The Top 10 in Telecommunications

Telecom companies are the big spenders of the U.S. economy, devoting fully 4% of their revenues on IS.

Company	IS Intensity	Revenue (\$Mil)	Profit (\$Mil)	FY End
AT&T	=	35,210	(1,669)	12/31
GTE	=	16,460	1,225	12/31
BellSouth	+	13,597	1,666	12/31
Nynex	=	12,661	1,315	12/31
Bell Atlantic	=	10,880	1,317	12/31
American Information	+	9,903	1,237	12/31
Pacific Telesis	=	9,483	1,188	12/31
US West	=	9,221	1,132	12/31
Southwestern Bell	=	8,453	1,060	12/31
United Telecom	-	6,493	509	12/31

Source: Business Research Group

Airlines Fly by Their IS Seats

The top 10 transportation companies traveled faster and farther on information systems than did most other sectors in 1988. Together, they spent \$2 billion or 2.6% of their \$76 billion in revenues on systems resources to deliver packages sooner, arrive on time more frequently and haul freight more efficiently.

The IS routes of the high fliers haven't changed much in going from there (1988) to here (1989). They allocated 50% of their IS dollars for personnel in 1988; they'll spend 48% of them on salaries and training this year. They bought hardware with 34% of their IS budgets last year; they'll spend as much on computers this year. They earmarked 7% for software in 1988; they're spending 8% of their IS dollars for systems and applications software in 1989. They experienced IS overhead expenses totaling 9% of their budgets a year ago; they have inched up to 10% today.

The high IS staff costs that continue to distinguish the transportation companies from most other sectors are due, in part, to their effort to develop in-house applications programs that will help distinguish their services from competitors'.

Competition is also heating up among the providers of computerized reservation systems. AMR Corp.'s SABRE, which controls 40% of the worldwide

The corporate offices of transportation giants are case studies in distributed computing.

reservation market, is being challenged by the Covia Partnership's Apollo system. Covia—owned by UAL Inc. and a consortium of other carriers—is aggressively adding new services in an attempt to win over new users. As SABRE and Apollo attempt to one-up each other, they will demand increasing portions of their parents' IS budgets. The other three reservation systems—PARS from Trans World Airline Inc. and Northwest Airlines, Delta Air Lines Inc.'s Datas II and System One from Continental Airlines Inc.—are also adding features to keep up.

Case Studies in Distributed Computing

A significant amount of the airlines' budgets goes to office automation. The corporate offices of transportation giants are case studies in distributed computing and networking. Their airport-based operations are not exactly old fashioned, either. Most support their ticket agents with personal computers and remote terminals linked to the corporate information systems.

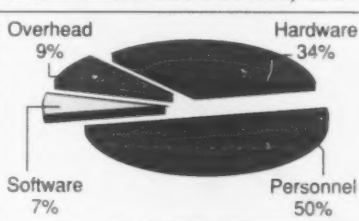
Where the airlines spend money on computerized reservations systems, United Parcel Service spends it on its shipping and tracking systems. In addition to maintaining flight schedules, UPS must maintain a worldwide fleet of trucks and must track millions of packages. In the highly

competitive overnight delivery business, the level of customer service can quickly make or break a shipper's reputation. Companies such as UPS must be able to instantaneously locate any one of their millions of shipments. UPS spends sizable sums to maintain and upgrade its customer databases, which turn over completely every few days as new packages enter the system and old ones exit. With worldwide operations, the company is also a big consumer of telecommunications services.

Although railroads continue to lag behind the airlines and the delivery services in IS spending, they are building up IS steam. At Santa Fe Southern Pacific Corp.'s Chicago headquarters, virtually all of the 135 corporate staff members have their own personal computers. The company recently sold its IBM model 4381 mainframe in favor of PCs, porting all of its critical applications software to the desktop systems. Some applications that defied conversion were turned over to an external service bureau, says Tom Kolb, manager of information systems for the railroad.

Railroad companies also are directing a good part of their IS budgets toward dispatching trains and monitoring their travels. Several well-publicized train crashes in recent years have added incentive to these investments, as human error has often been cited as the cause of many of the wrecks. While the rail companies don't expect to replace engineers with computers, they are installing automated systems that can serve as safety valves when standard procedures fail.

Distribution of IS Funds, 1988



The Top 10 in Transportation

Transport firms find that above average spending on IS lets them deliver sooner, arrive on time and haul more efficiently.

Company	IS Intensity	Revenue (\$Mil)	Profit (\$Mil)	FY End
United Parcel Service	+	11,032	758	12/31
UAL	+	9,015	1,124	12/31
AMR	+	8,824	477	12/31
CSX	=	8,668	147	12/31
Texas Air	-	8,573	(719)	12/31
Delta	=	6,915	307	6/30
Union Pacific	=	6,794	644	12/31
USAir	=	5,707	165	12/31
NWA	=	5,650	135	12/31
Santa Fe Southern Pacific	-	4,935	(47)	12/31

Source: Business Research Group